CLINICAL AND RADIOLOGICAL EVALUATION OF IMMEDIATE AND DELAYED SINGLE TOOTH IMPLANT PLACEMENT – 18 MONTHS, PROSPECTIVE, RANDOMIZED FOLLOWUP STUDY

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CERTIFICATE

This is to certify that **Dr.P.K.Sasikumar**, Postgraduate student in the Department of Periodontics, J.K.K.Nattraja Dental College and Hospital, Komarapalayam has done this dissertation titled **"CLINICAL AND RADIOLOGICAL EVALUATION OF IMMEDIATE AND DELAYED SINGLE TOOTH IMPLANT PLACEMENT – 18 MONTHS, PROSPECTIVE, RANDOMIZED FOLLOW-UP STUDY"** under my direct guidance during his post graduate study period 2008 -2011.

This dissertation is submitted to **THE TAMILNADU Dr. MGR MEDICAL UNIVERSITY,** in partial fulfillment of the degree of **MASTER OF DENTAL SURGREY, BRANCH II – Periodontics.**

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Dental epidemiological studies demonstrate that missing teeth are commonly present in all age groups.[1] The loss of a single tooth is regarded as a common cause of esthetic concern which leads to psychological implications and nonphysiologic occlusion, as a result of tipping of neighbouring teeth and supra eruption of opposing teeth.[2] The clinical replacement of lost natural teeth with osseointegrated implants has represented one of the most significant advances in restorative dentistry.

The primary reason for suggesting the "Fixed Partial Denture" is its clinical ease and reduced treatment time.[3] The patients have been advised to put their desire level of replacing missing teeth and accept the limitations of a fixed partial denture and removable partial denture.[6] Single tooth implant survival reports have been most validated as predictable methods of tooth replacement.[4, 5] However, the most natural method to replace a missing tooth is with an implant, rather than preparing adjacent teeth.[6]

The first single tooth crown restoration using a Branemark implant (Nobel Biocare) was placed in December 1982.[7] Since, Branemark introduced the "Osseointegration" concept, advancement has followed three paths.[8] This has been applied to replace a single missing tooth or multiple missing teeth in various edentulous situation, new donor sites and techniques to transplant bone have given better access to patients for receiving the implants and finally, efforts have been made to reduce the treatment period.

Single tooth implant can be placed either in healed extraction sites (delayed) or fresh extraction sockets (immediate). Traditionally a single tooth implant was placed in a healed extraction site, allowing ossification to occur in 3-6 months.[9] This

delay during socket healing, coupled with the added surgical stage, was inconvenient as well as uncomfortable to the patient, who might be wearing conventional removable prosthesis.[10]

To achieve optimal esthetics and reduced treatment time, immediate implant has been studied in the literature **(Becker EB et al.[11] 1998; Arad DS et al.[12] 1997; Grunder.U et al.[13] 2000).** In this type, the implant can be placed either immediately after the tooth extraction (Immediate) or 15 days after the tooth extraction (Delayed-immediate).[11] It was placed directly into fresh extraction sockets after preparation of the implant bed to achieve primary stability. Advantages of this technique includes preservation of the alveolar bone, the ideal axial positioning of implant using the socket as a reference, eliminating the waiting period of 3-6 months, fewer surgical visits and shortened edentulous period. On the other hand, there was a potential risk factor as enhanced possibility of mismatch between the socket wall and implant, leading to fibrous tissue formation.[9]

A two-stage surgical technique was originally advocated in order to optimize the process of new bone formation and remodelling, following implant placement.[10] To minimize the risk of soft tissue encapsulation, it has been recommended to keep the implants submerged and load free for 3 - 6 months.[14] Following this period, a second stage surgery was needed to connect the healing abutment to implant, holding the future prosthesis. After the second intervention, 4-6 weeks of healing period was needed for proper contouring of the soft tissue around a healing abutment, to allow for a predictable esthetic outcome.[15]

In one stage surgical procedures, flaps were sutured around the polished neck of implants avoiding the need for second stage surgical intervention.[14] **Misch et al.** suggested a terminology for immediate restoration or occlusal loading.[1] In general, when this protocol was first implemented, only one piece implants were used. However, later on, this procedure was performed with two-stage implants on which a healing abutment was placed.[16]

In implants, the criteria for success should involve the establishment of a soft tissue contour with intact interproximal papilla and a predictable gingival outcome.[17] The interdental bone and papilla height were correlated according to the distance from contact point to crestal bone. If the measurement from the contact point to the crest of the bone was 5 mm, the papilla would present almost 100%. If the distance was greater than 6 mm, the papilla would present 50% or less.[18] Based on this data, the clinician attempted to maintain 5 mm of distance from the contact point to the crestal bone, when placing the implant.

Adequate zone of keratinized mucosa measures as 2 mm of width, of which 1 mm was to be attached gingiva. The attached gingiva is necessary for the maintenance of gingival health and prevention of periodontal disease progression.[19] Peri-implant and periodontal tissues may differ in their resistance to bacterial infection because supracrestal collagen fibers in implants are oriented in parallel rather than a perpendicular configuration. This creates a much weaker mechanical attachment compared to natural teeth. Thus, adequate zone of keratinized mucosa adjacent to the implant has to be maintained.[20]

The influence of mucosal thickness on crestal bone loss around implant has been reported recently.[21] And it is necessary, that the minimum of 3mm of peri-implant mucosa is required for the stable epithelial connective tissue attachment around implants. A thick mucosa was resilient and therefore prone to pocket formation, while a thin mucosa was friable and thus often prone to gingival recession.[22]

The purpose of this study is to evaluate the width of keratinized gingiva, thickness of peri-implant mucosa, height of interproximal papilla, probing depth, soft tissue condition and bone loss around the single tooth implants. These parameter were compared clinically and radiologically between immediate and delayed single tooth implant techniques.

1. To evaluate and compare the overall and specific clinical and radiological parameters of immediate and delayed placement of single tooth implants.

2. To assess if any significant correlations exist between width of keratinized mucosa and health of peri-implant tissues around single tooth immediate and delayed implants.

Starting as early as the time of the ancient Egyptians in 2500 B.C., evidence exists of attempts at stabilization of periodontally compromised teeth with the use of gold ligature wires.

500 B.C- The Etruscan population utilized soldered gold bands incorporating pontics from animals to restore masticatory function as a bridge.

300 A.D- The Phoenican population developed a fixed bridge replacement utilizing carved ivory teeth stabilized by gold wire.

600 A.D- The first evidence of the use of implants was seen in the Mayan population. A mandible was found in 1931 by Dr. Wilson Popenoe in Honduras. It had three pieces of shell/ carved stone in place of the natural lower incisors. This fragment is the earliest example of a presumably successful endosseous alloplastic implant operation on a living person. The specimen was subjected to radiography by Babbio in 1970, which showed compact bone formation around two of the implants.

800 A.D- Quartz and Amethyst tooth implants were used in humans and the Inca skull kept in a museum in Peru showed thirty two teeth implants. 936-i0i3, Aibucasis de Condue, an Arabian surgeon, used implants made from ox bone. Abulcasiz di Zabra used implants made from cow's bone.

1809- Maggioto described the process of fabricating and inserting gold roots as a support system to the teeth. The implant was constructed by soldering three gold pieces in an approximate proportion of the socket created by the extraction of the tooth it would replace.

1913 - Greenfield, an American, developed the 'Greenfield Cage' endosseous implant.

1920- Leger Dorez introduced tubular extension implant.

1939- Strock brothers from Boston placed vitallium screw type implants to provide anchorage for replacement of a missing tooth.

Mid 1940's Manlio S Formiggini, an Italian, designed a spiral implant constructed by bending stainless steel or tantalum wire bent back upon it to form a series of spirals.

1948- Strock brothers placed the internally threaded root form submergible implant.

1943- Dahl first suggested the construction of the sub-periosteal implant. The original design was rather bulky with flat abutments and screws over the crest of the ridge.

1948- Goldberg and Gershkoff refined the subperiosteal implant with an extension of the framework to the external oblique region.

1950's- Bodine in his framework design, incorporated secondary struts, and screw holes were located in regions of bone density.

1952- Lew described the use of a direct impression technique. In addition fewer struts were utilized in the framework over the crest of the ridge.

1959- Lee described the progress and evolution of subperiosteal implants and further modified the framework to incorporate maximum strength and minimum bulk. Simple tapered abutments were utilized as the transmucosal abutments.

1950's- Lee introduced the use of an endosseous implant with a central post and circumferential extensions.

1958- Thomas T. Kieman made a buried implant in stainless steel, internally threaded and having the shape of and slightly larger than the root of an incisor.

1959- Raphael Chercheve, a Frenchman, also modified Formiggini's original design.

1963- Scialom described the use of tripodal endosseous pin arrangement.

1965- Branemark followed the sleep away design of Chercheve and claimed to acquire "osseous-integration" after leaving the implant buried for many years leading to "bone-fusion". The major breakthrough in implant success, which ultimately led to the very successful materials & techniques now being employed, was made in l952 by Per-Ing-var Branemark, in Sweden, while investigating wound healing. By chance it was discovered that titanium was biocompatible and when surgically placed in bone, direct bone contact and complete healing occurred. This reaction of the bone to titanium was termed "osseointegration".

Branemark's great contribution to implantology was his insistence that the bone had to be approached with a very low speed handpiece to reduce bone damage and that an implant if buried for several months and placement performed under ideal surgical procedures would osseointegrate. The first screw shape implants were placed

in patients in 1965. The technique was kept under research conditions and refined until 1985 when it was released to suitably trained practitioners.

Immediate implants

Placing the implant immediately or a short time after tooth extraction offers several advantages for the patient as well as for the clinician, including shorter treatment time, less bone resorption, fewer surgical sessions, easier definition of the implant position, and perhaps better opportunities for osseointegration because of the healing potential of the fresh extraction site.

Therefore, immediate methods of placement have increasingly become the procedure of choice. A number of animal studies have reported that successful osseointegration is possible when implants are placed immediately after tooth extraction, with or without the help of guided bone regeneration procedures. Different human studies have shown that the immediate implant placement method can provide a similar success rate as compared with delayed implant placement (90%). Long term data for immediate implants are available for up to 3 years.

Barzilay et al., (1991)[9] evaluated the effect of pure titanium implants into fresh extraction sockets, using an animal model for a 6 months functional period. This pilot study suggested that pure titanium implants had the potential to integrate when placed immediately after extraction of the teeth.

Bragger. U et al., (1991)[23] evaluated the efficacy of digital subtraction radiography for analyzing the peri-implant bone density. Standard radiographs were taken from both, human and animal. From a pair of standard radiographs, digitalized

pictures were taken and compared. They concluded that digital subtraction radiography might be one of the most sensitive non-invasive methods for assessing subtle density changes in peri-implant tissues.

Becker. W et al., (1992)[24] conducted a comparative study to identify the effects of membrane which was used alone or combined with PDGF and IGF-I or DFDBA in immediate extraction socket implants. This study revealed that implants which was grafted with PDGF and IGF-I plus membrane had significant results. The response to DFDBA was highly variable and it did not significantly improve the efficacy of the membrane.

Gher. ME et al., (1994)[25] evaluated the efficacy of bone graft and membrane in immediate implants. Hydroxyapatite (HA) coated and titanium plasma sprayed implants (TPS) were placed immediately in extraction sockets. This results suggested that 27 of 47 sites, showed clinical exposure of membrane and subsequent inflammation with significant bone loss.

Rosenquist. B et al., (1996)[8] evaluated the survival rate of immediate implants placed by a two stage surgical procedure for a period of 67 months. Although the incidence of infection around implants was higher in the periodontitis group, this study suggested that immediate placement of implants into extraction sockets is a safe and predictable procedure. The guidelines he suggested were two stage surgical protocols.

Schwartz. D et al., (1997)[12] evaluated the efficacy of autogenous graft in the treatment of immediate implants for 7 year period. The small autogenous bone chips (from bone adjacent to implant sites) were grafted into the defect between the implant

and the socket walls when needed. The results indicated that implants placed into the fresh extraction sites grafted with autogenous bone chips will heal predictably.

Becker. BE et al., (1998)[11] studied 134 implants placed at the time of tooth extraction in 81 patients and were not augmented with barrier membranes or graft materials. The implants were placed into good jaw bone anatomy and quality. The results of this study indicated that implants placed at the time of extraction without augmentation or grafting have excellent long term cumulative success rates.

Grunder. U et al., (2000)[13] evaluated the stability of mucosal topography around single tooth implants and adjacent teeth. One year after prosthesis insertion the soft tissue shrinkage on the buccal side of the crown was 0.6 mm on average. Therefore, they concluded that for the presence of a papilla, the bone level on the tooth side, not the implant side, is the determining factor.

Schropp. L et al., (2001)[26] evaluated efficacy of conventional tomography on prediction of the appropriate implant size. The implants were determined pre-surgically by periapical +panoramic images (record 1) and after surgery by peri-apical + panoramic images + tomographs (record 2). They concluded that the use of tomograms increase the efficacy of peri-apical + panoramic images with respect to implant size.

Smet. ED et al., (2001)[27] evaluated the influence of plaque or excessive loading on marginal hard and soft tissue reactions around implants. They concluded that marginal bone loss around osseointegrated implants has often been associated with peri-implantitis and also suggested that clinical observation was not sufficient to prove these relations.

Shou. S et al., (2002)[28] evaluated the efficacy of probing around implants and teeth with healthy or inflamed peri-implant mucosa or gingiva. They concluded that the probing measurements around osseointegrated oral implants and teeth were different and also suggested that mild marginal inflammation was associated with deeper probe penetration around implants in comparing to teeth.

Kan. JYK et al., (2003)[29] evaluated the implant success rate, peri-implant tissue response, and esthetic outcome of immediately placed and loaded maxillary anterior region. The patient was evaluated clinically and radiographically at implant placement and at 3, 6 and 12 months after implant placement. The result of this study suggested favourable implant success rates, peri-implant tissue responses, and favourable esthetic outcome.

Schropp L et al., (2003)[30] evaluated the bone and soft tissue contour changes following single tooth extraction. The tissue changes after removal of a premolar or molar in 46 patients were evaluated in a 12 month period by means of measurements on study casts, linear radiographic analyses, and subtraction radiography. They concluded that major changes of an extraction site occurred during 1 year after tooth extraction.

Esposito. M et al., (2007)[31] reviewed the difference in success rates between immediately, early and conventionally loaded implants. All randomized controlled clinical trials (RCTs) of root-form osseointegrated oral implants having a follow-up of 6 months to 1 year comparing the same osseointegrated root-form oral implants loaded immediately (within 1 week); early (between 1 week to 2 months); or

conventionally (after 2 months) were studied. They concluded that none of the meta-analyses revealed any statistically significant differences.

Degidi. M et al., (2008)[32] conducted a study to evaluate the immediate placement with immediate loading. This study concluded good esthetic results for immediately placed and restored implants and also suggested that the two adjacent implants should be placed at a distance greater than 2mm and less than 4 mm.

Romeo. E et al., (2008)[33] conducted a study of 48 patients with one tooth scheduled for tooth extraction and immediate implant placement. The author concluded that the combination of surgical and prosthetic plans represents the key factor to optimize predictability in single implant esthetics and also suggested that papilla presence is also correlated with a thick gingival biotype.

Guida. L et al., (2008)[34] evaluated the effect of immediate placement and loading of dental implants by human histological report. In this case report, one immediately loaded and the other one unloaded, were compared clinically and histologically. This case report concluded that immediate loading did not seem to impair osseointegration of an immediate post extraction implant compared to an unloaded post extraction one.

Buser. D et al., (2008)[35] evaluated the efficacy of biologic rationale and surgical procedure in immediate implants. The surgical technique was characterized by tooth extraction without flap elevation, bone augmentation on facial aspects 8 weeks after soft tissue healing. They concluded that significant esthetic outcomes were achieved by early implant placement with proper surgical procedures.

Crespi. R et al., (2008)[36] conducted a comparative study to assess the bone change around the immediate implants loaded either immediately or three months later. Implants were placed immediately after tooth extraction and were loaded immediately in the test group and after 3 months in the control group. They concluded that the success rate and radiographic results of immediately loaded implants were comparable to delayed loading group.

Becker. W & Goldsstein. M (2008)[37] reviewed the treatment planning and surgical technique for successful outcome immediate implant placement. They concluded that placement of bone graft at implant site was safe but did not promoting the osseointegration and also revealed that minimal invasive technique in the placement of immediate implants offered several advantages.

Kahnberg. KE et al., (2009)[38] evaluated the effect of bone graft material in the treatment of immediately placed implants for 2 years. The space between implants and sockets were filled with autologous bone graft material. They concluded that implants can be placed successfully in fresh extraction sockets using autologous bone graft material by a submerged surgical technique.

Grutter. L et al., (2009)[39] reviewed and evaluated the clinical and radiological assessment of the implant loading protocols for the partially edentulous esthetic zones. For periods of 1 to 5 years, the survival rate was 96.7%. However, for immediately placed implants with immediate restoration and occlusal loading, the survival rate dropped by approximately 10% (four studies).

Tortamano. P et al., (2010)[40] assessed the dimensional stability of peri-implant soft tissues around immediately placed and restored implants in the maxillary

esthetic zone. Peri-implant soft tissue dimensions were measured either by direct clinical examination or evaluation of study casts. They concluded that the immediate implants with immediate restorations can be a predictable option for the replacement of teeth in the esthetic zone.

Valentini. P et al., (2010)[41] evaluated the clinical and radiological features of immediate loading of single tooth immediate implants. In 78% of patients, the papilla was completely preserved. They concluded that single-tooth rehabilitation patients with buccal or circumferential defects can be treated with a favorable esthetic outcome using the immediate loading approach.

Kan. J et al., (2010)[42] evaluated the reliability of assessing visually the facial gingival biotype of maxillary anterior teeth with and without the use of a periodontal probe in comparison with direct measurements. Three methods were used to evaluate the thickness of the gingival biotype: visual, periodontal probing, and direct measurement. Assessment with a periodontal probe was an adequately reliable and objective method in evaluating gingival biotype**.** The visual assessment of the gingival biotype was not sufficiently reliable.

Delayed implants

Use of the Branemark system (Nobelpharma AB, Goteborg, Sweden) to provide support for the replacement of single tooth was an inevitable treatment opinion that has recently evolved. The method is based on gentle surgical introduction of a pure titanium implant into the vital bone and the biocompatibility of titanium, which permits osseointegration. Clinical data concerned with the soft tissue response

to transepithelial titanium abutments attached to the implant have confirmed a clinical and histological status comparable to that of a natural tooth.

Albrektsson. T et al., (1988)[43] evaluated the success rate of implants based on success criteria. The success criteria included absence of implant mobility, absence of radiolucent zones on X- rays, and an annual bone loss of less than 0.2 mm after one year. It was concluded that osseointegrated implants, if inserted according to the guidelines of Branemark, could achieve a high degree of clinical success.

Jemt. T et al., (1991)[44] has studied 107 Branemark implants in single isolated edentulous areas. The gingival condition was healthy around the single crowns and coincided well with the clinical situation around the permanent teeth. This short-term study has indicated a promising technique for placing and maintaining the stability of implants for support of single tooth restorations. Problems associated with this study was stability of the screw joint

Ekfelt. A et al., (1994)[6] evaluated 93 single tooth implants placed using two stage surgical protocols. Only two implants were lost; one before the abutment operation and one during the first year in function. From this clinical study, it can be concluded that implants were an effective treatment alternative offering promising results for the replacement of a missing single tooth.

Laney. WR et al., (1994)[45] conducted a study of 107 delayed implants in 92 patients for 3 years. This prospective, multicenter study of single Branemark system implants (Nobelpharma AB, Goteborg, Sweden) was initiated in 1987. Marginal bone resorption remained at levels less than 0.1 mm annually, it was a significantly reduced

rate from that reported after 1 year. Titanium abutment screws had favorable outcomes than gold.

Andersson. B et al., (1995)[46] estimated the success rate of 102 CeraOne implants placed in single edentulous site, using two stage surgical procedures for 3 years. It was proven that the system achieves good esthetic results and avoids the complications of screw loosening and fistula formation. The author concluded that utilization of the CeraOne system provided good esthetic results.

Henry. PJ et al., (1996)[47] conducted a prospective 5-year multicenter study of delayed single tooth implants for 5 years. Plaque and gingival indexes showed similar pattern of good health around both natural teeth and titanium abutments. The marginal bone loss during the 5 year period did not exceed 1 mm as a mean, for all implants analyzed. The Branemark single tooth implants were highly predictable in this study.

Jemt. T (1997)[48] evaluated regenerated gingival papilla after a single tooth implant replacement. The interproximal gingival papilla was assessed using the Jemt index. The results indicated that significant spontaneous regeneration of papillae was achieved after a mean follow-up period of 1.5 years. They concluded that the proposed index allows scientific assessment of soft tissue contour adjacent to single-implant restorations.

Scheller. H et al., (1998)[49] studied the success rate of Branemark implants for single tooth replacements for 5 years. Mean marginal bone resorption was well within the limits set by Albrektsson et al. in 1986. The status of the soft tissue around crowns and adjacent teeth remained stable over the evaluation period. The results

suggested that the Branemark system can be safely used for tissue-integrated replacement of single teeth.

Chang M et al., (1999)[50] compared the clinical conditions between an implant supported single tooth and the contralateral tooth. The results revealed that, the implant supported crown showed increased bleeding on probing, probing depth, and higher frequency of mucositis score. The longitudinal evaluation of the papilla adjacent to the implant crown showed an improved proximal soft tissue fill at the follow-up examination.

Romanos. JE et al., (2000)[51] evaluated the clinical response of progressive thread design (Ankylos) implants in the treatment of molar teeth. Fifty-eight implants (10 in the maxilla and 48 in the mandible) were placed in 51 patients. The reduced incidence of failure found in this study with the Ankylos implant system compared to the results reported in the literature indicate that this system can be used for the replacement of molars using single implant-supported restorations.

Tarnow et al., (2000)[52] evaluated the crestal bone height to horizontal distance between 2 implants in relation to the presence of papilla. Of the 36 patients studied, the radiographs were evaluated between 1 and 3 years. Implants were categorized into groups based on whether the distance was greater or less than 3 mm; a predetermined value selected by the authors. It was implied that increased crestal bone loss would occur if the inter-implant distance was less than 3 mm.

Cooper. L et al., (2001)[53] conducted a study in 54 delayed single tooth implants restored after 3 weeks of one stage surgery. A high success rate with positive tissue responses was achieved for maxillary anterior unsplinted single tooth implants

placed in a one stage surgery and restored at 3 weeks. This two component system was suited to a single-stage, rapid loading protocol for esthetic single tooth replacement.

Choquet. V et al., (2001)[18] evaluated the papilla levels adjacent to single implants by a clinically and radiographic method. They concluded that, if the measurement from the contact point to the crest of the bone was 5 mm or less, the papilla would present almost 100%. If the distance was ≥6 mm, the papilla would present 50% or less. The results clearly showed that there was direct influence of the bone crest on the presence or absence of papilla between implants and adjacent teeth.

Kan. J et al., (2003)[53] evaluated the dimension of peri-implant mucosa of maxillary single tooth implants. The dimensions of peri-implant mucosa in the thick biotype were significantly greater than the thin biotype. They concluded that the level of the interproximal papilla of the implant was independent of the interproximal bone next to the implant, but it was related to the interproximal bone level adjacent to teeth. The thick peri-implant biotype had greater peri-implant mucosal dimension.

Gastaldo. JF et al., (2004)[54] evaluated the effect of vertical and horizontal distances between adjacent implants and between a tooth and an implant on the incidence of interproximal papilla. They concluded that the ideal distance from the base of the bone crest between adjacent implants were 3 mm and, between a tooth and an implant were 3mm to 5 mm. Ideal lateral spacing between implants and between tooth and implant is 3 to 4 mm.

Henriksson. K et al., (2004)[55] measured the soft tissue volume in association with single-implant restorations. They concluded that buccal tissue was increased

significantly after placement of abutment and crown. This increase of buccal contour was reduced after 1 year. Furthermore, no relationship was established between the presence of papilla and the distance between the contact point and underlying bone crest.

Appleton. R et al., (2005)[56] evaluated a radiographic assessment of progressive loading on bone around single osseointegrated implants in posterior maxilla. The progressive loaded crowns were placed in infra-occulsion for the first 2 months, light occlusion for the second 2 months, and full occlusion for the third 2 months. They concluded that the peri-implant bone around progressively loaded implants demonstrates less crestal bone loss than the bone around implants placed conventionally into full function with increased bone density.

Ryser. M et al., (2005)[57] **conducted** a **s**tudy to evaluate papilla fill between immediate or delayed loading of single tooth implants. They concluded that as the distance from the contact point to the implant increased, there was a significant chance in the loss of papilla. There was no difference between delayed or immediate loading and papilla scores. The horizontal distance from adjacent tooth bone level did not correlate to papilla score within the range of clinically relevant distances.

Romeo. E et al., (2006)[58] conducted longitudinal study to evaluate clinical and radiological parameters of small diameter implants followed for 1-7 years. The study was to compare the prognosis of narrow implants (3.3 mm diameter) to standard (4.1 mm diameter) implants. They revealed that cumulative survival and success rate of small diameter implants and standard-diameter implants were not statistically

significant and also suggested that small-diameter implants can be successfully used in the treatment of partially edentulous patients.

Meijindert. L et al., (2006)[59] conducted prospective randomized clinical study to evaluate esthetic aspect of single tooth delayed implant using the different bone augmentation procedure in bone defect site. The author concluded that the peri-implant mucosa had less satisfactory esthetic result by augmented procedure.

Cardaropoli. G et al., (2006)[60] evaluated the dimensional alteration of the peri-implant tissues at single tooth restoration from the time of implant placement to 1-year post-loading. Assessments of the soft tissue at the implant site and at the neighbouring teeth were performed 1) before and during implant placement 2) before abutment connection 3) after crown placement and at the 1-year follow-up examinations. They concluded that observed soft tissue alterations after the crown placement may affect the esthetic appeal of the restorative therapy.

Watzak .G et al., (2006)[61] evaluated radiological and clinical parameters of two types of implants with respect surfaces of implants. This study was followed for 33 months and peri-implant bone loss was assessed using panoramic radiograph. In this method, implants were placed at crestal bone level and bone loss was measured from implant platform to crest of bone. They concluded that both implants produced excellent results.

Misch. C et al., (2008)[62] evaluated posterior single tooth implant survival and long-term conditions of the adjacent teeth for a 10 year period. Long term adjacent tooth conditions like decay, endodontic therapy and extraction during follow up visits were assessed. They concluded that the use of single tooth implants as replacement

for posterior missing teeth is viable long term treatment and adjacent natural teeth complications are minimal for as long 10 year after implant insertion.

Bouri. A et al., (2008)[19] conducted a study to determine whether an association exists between the width of keratinized mucosa and the health of implant-supporting tissues. Implants with a narrow zone of keratinized mucosa were more likely to bleed upon probing, even after adjusting for Plaque Index, smoking, thickness of the gingiva, and time since implant placement. They concluded that increased width of keratinized mucosa around implants is associated with lower mean alveolar bone loss and improved indices of soft tissue health.

Shahindi. P et al., (2008)[63] compared the efficacy of a new uncovering technique with that of the conventional uncovering technique for papilla generation. Implants of the test group were uncovered by the new technique and implants of the other group were uncovered by the conventional technique (simple mid-crestal incision). Based on this study, it appears that over the course of 6 months, the new surgical approach for uncovering leads to a more favorable soft tissue response.

Linkevicius. T et al., (2009)[21] evaluated the influence of gingival tissue thickness on crestal bone loss around dental implants after a 1-year follow-up. According to tissue thickness, the test implants were divided into A (thin) and B (thick) groups. They concluded that initial gingival tissue thickness at the crest may be considered as having a significant influence on marginal bone stability around implants. If the tissue thickness is 2.0 mm or less, crestal bone loss up to 1.45 mm may occur, despite a supracrestal position of the implant-abutment interface.

Kyun. Y et al., (2010)[64] evaluated the prognosis of single molar implant restorations. They concluded that risk for failure of maxillary and mandibular single molar implants was high and the possibility of developing prosthetic complications during loading is also high. Therefore, to minimize the cantilever, implants must be placed precisely and followed up carefully and maintained for a long period of time.

Immediate and delayed single tooth implants

Yukna. A et al., (1991)[65] evaluated the clinical comparison of Hydroxyapatite-coated titanium dental implants placed in fresh extraction sockets and healed sites. There were no significant differences in any clinical parameter between those implants placed in fresh extraction sockets and those placed in healed areas. Periodontal health, maintenance of crestal bone levels, and implant stability were excellent for implants placed in both types of recipient sites.

Grunder. U et al., (1999)[66] conducted a 3- year prospective study to evaluate and compare immediate and delayed-immediate implant placement. Clinical parameters (bleeding on probing, pocket depth, and implant mobility) were evaluated after 1 and 3 years, and the marginal bone level after 1 year of loading was measured on radiographs. This study concluded that Branemark implants placed according to an immediate or a delayed-immediate method can be successful over a period of 3 years.

Schropp. L et al., (2003)[67] evaluated the bone healing following immediate versus delayed placement of titanium implants into extraction sockets**.** The implants were placed on an average, 10 days following tooth extraction in the immediate group and approximately 3 months after extraction in the delayed group. They concluded

that new bone formation occurs in infrabony defects associated with immediately placed implants in extraction sockets compared with delayed implants.

Covani. U et al., (2004)[68] evaluated the bucco-lingual crestal bone changes after immediate and delayed implant placement. No membrane or filling materials were used. This study suggested that circumferential defects could heal clinically well without any guided bone regeneration (GBR) in both experimental groups. They concluded that the preferred timing of implant placement influences the different rate of bone remodeling around immediate or delayed implants in the sites of high esthetic concern.

Schropp. L et al., (2004)[69] evaluated the patient experience and satisfaction between delayed-immediate and delayed single tooth implant placement. The study was to compare the surgical and prosthetic procedures and functional and esthetic satisfaction between early and delayed single tooth implants. Assessment of the implant surgery was not significantly different between the delayed-immediate and delayed group. The patients of this study were highly satisfied with the outcome of the treatment and experienced it without significant unpleasantness irrespective of the treatment concepts.

Arad. SD et al., (2004)[70] evaluated radiological crestal bone loss with immediate and delayed placed implants for fixed restorations in edentulous jaws. The study was to examine the cervical bone level (CBL) and its correlation with implant characteristic and anatomic factors, 1 to 8 years post-implantation of immediate and delayed implants. They concluded that cervical bone loss around dental implant was influenced by location, coating, length, and implant timing.

Zetu. L et al., (2005)[71] reviewed and compared the effectiveness of existing technique for creation of inter implant papilla and also to address the factors that may influence its appearance. The key for achieving an esthetically pleasing outcome is the clinician's ability of properly managing/ creating inter-implant papilla. They concluded that an esthetic triangle developed as a result of precise surgical techniques were essential for maintaining or creating the interproximal papilla. These include adequate bone volume, proper soft tissue thickness as well as esthetic restorations.

Schropp. L et al., (2005)[72] conducted a study to evaluate the interproximal papilla levels following early versus delayed placement of single tooth implants for 18 months. The soft tissue fill in the proximal spaces improved significantly from baseline to the 1.5 year follow-up in both groups, with no significant difference between groups found at follow-up. They concluded that early placement of single tooth implants may be preferable to a delayed implant placement technique in terms of early generation of interproximal papilla.

Jaffin. RA et al., (2007)[73] evaluated the radiographic bone loss pattern adjacent to immediately placed, immediately loaded implants. The study was to evaluate radiographic bone levels adjacent to implants placed in fresh extraction sockets (ES) and immediately loaded with a fixed full mouth provisional restoration compared to bone levels adjacent to implants in native bone (NB) under the same conditions. They suggested that the combination of extraction sockets and native bone implants can be immediately loaded with a fixed full-arch prosthesis and remain stable for greater than 5 years.

Hartog LD et al., (2008)[10] reviewed about the single tooth implants. This systemic review was done to evaluate survival rate, bone level, soft tissue, aesthetics and patient satisfaction of delayed and immediate single tooth implants placed in the esthetic zone. No significant differences in outcome measures were reported in clinical trials comparing immediate, early or conventional implant strategies. They concluded that promising short term results could be achieved for immediate, early and conventional single tooth implants in the aesthetic zone.

Degidi. M et al., (2008)[74] conducted retrospective analysis to evaluate the peri-implant tissue and radiological bone levels in the immediately restored single tooth implants. Bone loss was significantly greater in the post extraction sockets compared to the healed sites. No significant correlation was found between bone loss and papilla presence. They concluded that in the interproximal area between the implant and the natural tooth, the papilla does not seem to be affected by the peri-implant bone loss. Immediate restoration did not seem to cause a greater average amount of bone loss compared to that reported previously for one- and two- stage surgical procedure after the first year of function.

Atieh. MA et al., (2010)[75] assessed the survival of immediately placed single tooth implants in fresh molar extraction sites and immediately restored/loaded single molar implants in healed molar sites. Favorable marginal bone level changes in the immediate loading group were detected at 12 months. They concluded that immediate placement and immediate restoration/loading of single implants in mandibular molar regions showed significant results.

This study was designed and conducted by the Department of Periodontics, JKKN Dental College and Hospital, Komarapalayam, to Evaluate the clinical and radiological parameters of immediate and delayed single tooth implant technique.

Materials

A Hi-Tech implant (Life care implants) made up of titanium with self-threaded internal hex and selective integrated surface were used. The four diameters and two prosthetic platforms (standard and wide platform) of implants are available with variable diameters and lengths 3.3, 3.75, 4.2, 5.0 mm and 8, 10, 11.5, 13, 16 mm. It has round end that protects and prevents sinus membrane perforation.

Method

Study-Design

A randomized, prospective clinical trial was conducted to evaluate the clinical and radiological parameters of immediate and delayed single tooth implant placement. Fresh extraction sites with immediate implant technique and healed site with delayed implant technique were followed. The ethical **c**learance was obtained from the institutional ethical board prior to the start of the study. 14 (eight females, six males) patients of both sexes with an age limit of 20-35 years were selected for the study from outpatient Department of periodontics depending on the following selection criteria.

Inclusion criteria

1. Single tooth space or space with adjacent natural tooth [2]
2. Adjacent teeth: intact; restored with functionally and esthetically good restorations; restored with prostheses precluding the addition of the missing tooth[2].
3. Patient reluctance of preparation of adjacent teeth[2]
4. Demonstrated maladaptive experience, or psychological reluctance to wear a removable partial denture[2]

Exclusion criteria

1. Inability to undergo a minor oral surgical procedure.[2]
2. A history of substance abuse[2]
3. Psychoses[2]
4. Unrealistic esthetic expectations[2]
5. Presence of vital anatomic structure in very close proximity to a proposed implant site[2]
6. Insufficient bone quality or compromised health of the local site as determined by radiographs and clinical inspection before implant placement (local cysts, soft tissue ulceration, persistent infections, insufficient healing of the previous extraction site)[2]

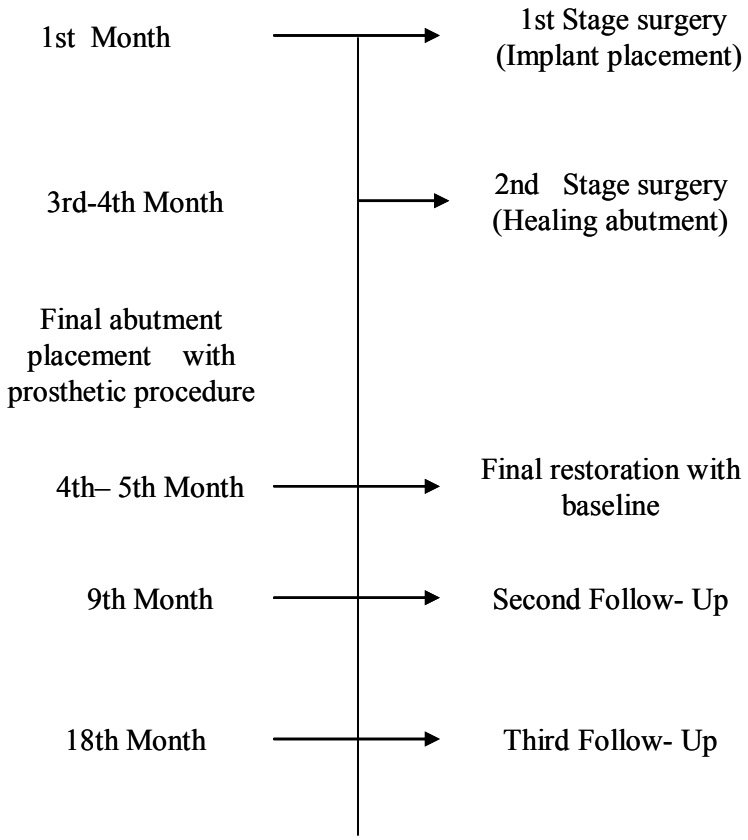
7. Insufficient bone quantity[2]

8. Inadequate mouth opening[2]

9. Insufficient vertical inter arch space to accommodate the prostheses[2]

10. Incomplete facial growth and teeth eruption[2]

STUDY DESIGN [32]



The nature and design of the clinical trial was explained to the patients and consent was obtained for their participation. All the patients were subjected for scaling and oral hygiene instructions were given (appendix-1).

Criteria for grouping

The single tooth implant sites were randomly selected in either the upper or lower jaw, irrespective of whether it was an anterior or posterior region. The selected patients were categorized into two groups based on immediate and delayed implant placement protocols.

Immediate Group

Seven single tooth implants placed using immediate technique in the fresh extraction sockets.

Delayed Group

Seven single tooth implants placed using delayed technique in the healed bone sites.

Pre-Surgical procedure

The intraoral, panoramic radiographs were taken for the preoperative evaluation of the bone quality, implant position and orientation. The diagnostic template was made which has 5 mm ball bearing, incorporated around the curvature of the dental arch and worn by the patient during the radiographic examination, which enabled the operator to determine the amount of magnification in the radiograph.[1] Based on the anatomical site analysis, the appropriate implant diameter and platform size was selected to best fit the single tooth edentulous area. After a preoperative workup, a diagnostic wax-up of the planned restoration and fabrication of a surgical stent was done before the implant surgery. This stent was made for proper

positioning of implant shoulder and provide an ideal emergence profile with long term peri-implant hard and soft tissue support.[76]

Surgical procedure

All the 14 patients were surgically prepared with routine blood investigation and radiographic assessment. Local anesthesia was induced by infiltration with lignocaine (2%) and adrenaline (1:80,000) for the both groups.

Immediate group

Following local anaesthesia, teeth were luxated with an elevator and extracted carefully with forceps (attempting to preserve the bone of the alveolus), and the sockets were debrided. A crestal incision connected with two vertical releasing incisions mesial and distal to the extraction site was performed with elevation of mucoperiosteal flap.[67] The depth, bucco-lingual and mesio-distal dimensions of the alveolar socket were measured with ridge caliper and an implant with appropriate dimension was selected. Then implant was placed using pilot, intermediate and final drill in such a way that cover screw was corresponding to the level of the adjacent bone. Primary closure of the wound was achieved by stabilization of the flap using interrupted suture with 3-0 silk thread.

Delayed group

After achieving profound anesthesia, the mucoperiosteal flap was elevated with a crestal incision located approximately 2 to 3mm toward the lingual aspect and extended to the sulcus of adjacent teeth by intra-sulcular incision. This incision avoids the formation of scar tissue in the mid crestal area. The bucco- lingual and mesio-

distal implant position was partially determined by the morphology of alveolus. Then the implant was placed using pilot, intermediate and final drill in such a way that cover screw was corresponding to the level of the adjacent bone. The primary closure of the wound was achieved by stabilization of the flap with simple interrupted suture 3-0 silk thread.

Antimicrobial prophylaxis (Amoxicillin 500 mg) was given one hour before surgery and continued twice daily for 7 days. Post-surgical analgesics (paracetamol 500 mg + Aceclofenac 100 mg) were prescribed twice daily for one week and oral hygiene instructions were given (appendix-1). The suture was removed one week after the implant surgery.

After 3 months of implant placement, the patients were subjected to a second surgical procedure. Healing abutments were mounted on to the implants in order to condition the peri-implant soft tissues for 4-6 weeks. This healing abutment connection was done by a simple midcrestal incision (Shahindi. P et al.)[63]. Later, final abutment was selected and placed at 35 Ncm by using torque wrench. The prosthetic crown was prepared, cemented with type II GIC cement and baseline data were recorded. Then the patients were recalled for further follow up at 9^{th} and 18^{th} month corresponding to a functional loading time of 4 months and 1 year respectively.

Clinical parameters

Assessment of soft tissues at the implant site was performed after crown cementation at baseline, 9 & 18 month by single examiner. At the follow up visits, the following parameters were assessed,

1. Width of keratinized mucosa (*Bouri A et al*., 1999)[19]

2. Thickness of peri-implant mucosa (*Austria M et al*., 1992)[19]

3. Papilla Index (*Jemt T* 1997)[57]

4. Plaque index (*Mombelli et al.* 2004) [20]

5. Soft tissue index (*Bengazi et al.* 2004)[50]

6. Probing depth (*Schropp et al.* 2005)[15]

Evaluation methods

1) Width of Keratinized Mucosa: [19]

The width of the keratinized mucosa was measured at the mid-facial aspect of each implant using UNC 15 (equinox)® probe. Each measurement was made from the gingival margin to the mucogingival junction. The mucogingival junction was identified by the rolling technique, where in the mucosa was rolled until the nonmovable portion of the attached keratinized tissue was identified.

2) Thickness of Peri-Implant Mucosa: [19]

The thickness of the gingiva around dental implant was measured approximately 2 mm apical to the gingival margin on the facial aspect of the implant. After topical anesthetic application, the thickness was measured gently inserting a sterile Endo reamer with a rubber stopper, until contact of the underlying bone structure. The gingival biotype was considered thin if the measurement was less than 1.0 mm and thick if it measured greater than 1.0 mm.[42]

3). Papilla Index: [57]

Clinical photographs were taken with single examiner using the same magnification and illumination. These photographs were digitalized at a resolution of 1,000 dpi. Papilla was scored using a modified scale previously described by Jemt. The index was defined briefly as,

Score 1: No Papilla was present.

Score 2: Less than 50% filling with minimal papilla present

Score 3: Papilla that did not fill the space completely and had over 50% of the space filled.

Score 4: The papilla fills up the entire interdental space and had comparable filling to adjacent, non-implant restored papilla.

4). Plaque index: [20]

The oral hygiene status was evaluated by the presence or absence of visible plaque present at the soft tissue margin. The six index teeth selected were 16, 12 and 24, 36, 32, 44.

Score 0: No plaque

Score1: Plaque only recognized by running a probe across the smooth marginal surface of the implant.

Score 2: Plaque can be seen by the naked eye.

Score 3: Abundance of soft matter within the gingival pocket and or on the gingival margin and adjacent tooth surface.

The plaque score was obtained by totaling the four plaque scores per tooth and then divided by four. The plaque score per person is obtained by adding the plaque score per tooth & dividing by the number of teeth examined.

The scoring criteria are as follows

0.1-0.7 – Good

1.8- 3.4 – Fair

3.5-5.0 - Poor

5). Soft Tissue index: (Mucositis score, Bengazi et al 1996)[50]

Indices used to assess marginal mucosal conditions around oral implants are followed,

Score 0: No color or texture alterations

Score 1: Slight change in color and texture.

Score 2: Marked change in color or texture and bleeding following superficial probing.

6) Probing Depth: [15]

Probing pocket depth was measured at the buccal, mesial, distal and lingual aspects of the single tooth implant by plastic probe (Hu-friedy)®.

RADIOGRAPHIC ASSESSMENT

Radio Visio graphs (RVG) of the implants were obtained after 2nd stage surgery during cementation of the crown. The CCD (Charge Coupled Device) of RVG was kept in precise orientation with bisecting angle technique and data was recorded. The assessment was carried out at baseline, 9th and 18th month follow up visits. Radiographs were digitalized and analysed for peri-implant bone loss using Sopro imaging software.

Measurements: (Watzak. G et al., 2006)[61]

Peri-implant marginal bone loss mesial and distal to each implant was assessed by measuring the vertical distance between implant-abutment interface and the implant apex, also the bone level from the crest to implant apex**.** The difference between these two distances was defined as peri-implant bone loss.

To minimize the dimensional distortion**,** the apparent dimensions of the implants were measured on the radiographs and divided by the actual implant size. Corresponding bone loss in millimeter detected radiographically was divided by the magnification factor to obtain the actual bone loss.

Appendix-1

Instructions to the Patient

1. Advised to follow the prescribed medication.
2. To perform regular oral hygiene habits by appropriate brushing technique using tooth brush and tooth paste.
3. 0.2% chlorhexidine gluconate rinse twice daily for 2 weeks after surgery.
4. In case of discomfort, patients were advised to report immediately.
5. Patients were instructed to maintain a soft diet for 4 weeks
6. The patients were dispersed and instructed to report at regular intervals.

Appendix- 2

ARMAMENTARIUM

MATERIALS AND INSTRUMENTS USED FOR IMPLANT SURGERY:

- Gloves
- Mouth mask
- Patient apron
- Chair apron
- Head cap
- Sterile gauze
- Saline
- Betadine
- Kidney tray
- Lignocaine
- Syringe
- Mouth mirror
- Straight Probe
- Explorer

- William's graduated periodontal probe
- Hu-Friedy plastic probe
- UNC 15 probe
- Ridge caliber
- Metal scale
- Bard Parker handle
- Bard Parker blade no 11, 15
- Periosteal elevator
- Tweezer, Tissue holding forceps
- Ultrasonic scalers
- Gracey Curettes
- Physio dispenser
- Implant kit
- Extraction forceps
- Autogenous bone scraper (Ebner grafter- Salvin dental specialist, USA)
- Dappendish
- Bio-oss®

- Plastic instruments
- Amalgam condenser
- Needle holder
- 3-0 suture material
- Cutting scissors

Appendix-3

PROFORMA

Op No : Date:
Name: Age:
Sex: Ph no:
Occupation:
Address:

Chief complaint:

Delayed Implant: ☐ Immediate implant: ☐

Pre-surgical Medical History:

Pre-surgical Dental History:

Oral Hygiene Habits :

Materials used to clean the teeth:

If Brush:

1) Type of Brush
2) Paste/Powder/Others
3) Frequency of Brushing
4) Method of brushing

Pre-surgical Oral examination:
Extra Oral Examination:

Intra Oral examination:

Information on bone quantity: (Misch)

Type I
Type II
Type III
Type IV

Type of placement:

Implant Region:

Implant tooth site:

Adjacent Tooth:

Duration:

(Partial edentulous period for delayed implant/ Fractured or Grossly destructed tooth period for immediate implant)

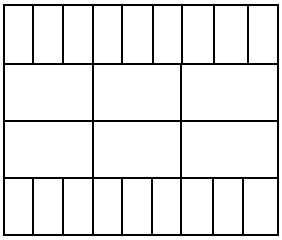
Implant size: Diameter: Length:

CLINICAL PARAMETERS

Oral Hygiene Status: (Plaque index, percentage)

Baseline

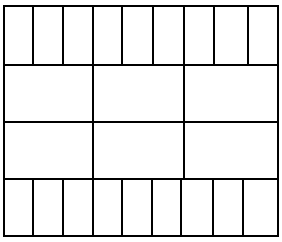
16 12 24



44 32 36 **SCORE** ☐

9th Month

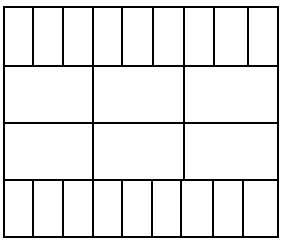
16 12 24



44 32 36 **SCORE** ☐

18th Month

16 12 24



44 32 36 **SCORE** ☐

Soft tissue conditions; (Mucositis score)

	Score level
Base line	
9th month	
18th month	

Width of keratinized gingivae: (Facial side)

	At mid line of the crown (in mm)
BaseLine	
9thmonth	
18th month	

Papilla index score; (Jemt. T, 1997)

	Mesial	Distal
Base line		
9th month		
18th month		

Thickness of peri-implant mucosa: (mm)

(2 mm below the gingival margin at the mid line of the crown)

	At the mid facial crown
Base line	
9th month	
18th month	

Probing depth: (mm)

	Mesial	**Distal**	**Buccal**	**Lingual**
Baseline				
9 month				
18 month				

Radiological assessment:

Peri-implant Bone Loss: (mm)

	Mesial	**Distal**
Base line		
9th months		
18th months		

Consent Form

DEPARTMENT OF PERIODONTICS, JKK NATARAJA DENTAL COLLEGE, KOMARAPALAYAM- 638183

PATIENT NAME

I have been explained about the nature and purpose of the study in which, I have been asked to participate. I understand that I am free to withdraw my consent and discontinue at any time without prejudice to me or effect on my treatment.

I have been given the opportunity to question about the material and study. I have also given the consent for photographs to be taken at the beginning, during and at the end of the study. I have fully agreed to participate in this study.

I hereby give the consent to be included in "CLINICAL AND RADIOLOGICAL EVALUATION OF IMMEDIATE AND DELAYED SINGLE TOOTH IMPLANT PLACEMENT-18 months prospective, randomized, follow-up study.

Station:

Date :

Signature of the Patient

Signature of the professor

STATISTICAL ANALYSIS METHOD

In this study **Student *t* – distribution (William Sealy Gosset)** is used to analyze the significance between the groups at different time intervals.

The *t* –distribution is used when the sample size is small (less than 30) and standard deviation of the population is unknown.

Independent-Samples t Test

The Independent-Samples t Test procedure compares means for two groups of cases. Ideally, for this test, the subjects should be randomly assigned to two groups, so that any difference in response is due to the treatment (or lack of treatment) and not due to other factors.

According to this test,

The *t* – statistic is defined as

$$t = \frac{\overline{X} - \mu}{S} \times \sqrt{n}$$

Where

$$S = \sqrt{\frac{\sum (X - \overline{X})^2}{n-1}}$$

Whereas ***s*** is simple standard deviation of the sample and ***n*** is the sample size, the degree of freedom used is $n - 1$.

In the present study, $p > 0.05$ was considered as significant at 5% level of significance.

A total of 12 patients with 14 single tooth implants were participated in this study. In which seven implants were placed immediately after the tooth extraction, and seven implants were placed in healed extraction sockets. The implants were clinically and radiolographically evaluated based on the implant placement.

Plaque index

In immediate group, the mean plaque index score at baseline was 0.28±0.48 that increased to 0.42 ±0.5 at the end of 9 months and 0.57±0.53 at 18 months. In delayed group at baseline, it was 0.14 ± 0.37 that increased to 0.57 ±0.53 at the end 9 months and 0.71±0.48 at 18 months. On comparison between delayed & immediate group, it was not statistically significant ($p>0.05$) as shown in table 1.

Soft tissue index

In immediate group, the mean soft tissue index at baseline was 0.14±0.70 that increased to 0.28 ± 0.42 at the end of 9 and 18 months. In delayed group at baseline, it was 0.14±0.70 that increased to 0.28±0.42 at end of 9 and 18 months. On comparison between delayed & immediate group, it was not statistically significant ($p>0.05$) as shown in table 2.

Width of peri-implant keratinized mucosa:

In immediate group, the mean width of keratinized mucosa at baseline was found to be 5.01±1.08 mm that decreased to 4.85±0.69mm at the end of 9 months and 4.71±0.75mm at 18 months. In delayed group at baseline, it was 5.00±1.29mm that decreased to 4.64±1.65mm at the end of 9 months and 4.57±1.62mm at 18 months.

On comparison between delayed & immediate group, it was not statistically significant ($p>0.05$) as shown in table 3.

In percentage, the immediate group showed 5.8% reduction and in delayed group it was 8.6% at 18th months as shown in table 8.

Thickness of peri-implant mucosa:

In immediate groups, the mean thickness of mucosa at baseline was found to be 2.07±0.41 mm that increased to 2.42±0.81mm at the end of 9 month and 2.50±0.86 mm of 18th months. In delayed group at baseline, it was 1.92±0.55 mm that increased to 2.35 ± 0.37mm at the end of 9 months and 2.42± 0.5mm at 18 months. On comparison between delayed & immediate group, it was not statistically significant ($p>0.05$) as shown in table 4.

In percentage the immediate group, it was increased to 24.15% and in delayed group it was increased to 25.9% at 18th month as shown in table 8.

Papilla index

In immediate group, the mean papilla index at baseline was found to be 2.57±0.97 that increased to 2.71±0.73 at the end of 9 months and 2.85±0.83mm at 18th months. In delayed group at baseline, it was 2.64±0.73 that increased to 2.71±0.75 at the end of 9 months and 2.92 ±0.18 at 18 months. On comparison between delayed & immediate group, it was not statistically significant ($p>0.05$) as shown in table 5.

In percentage the immediate group, it was improved to 10.89% and in delayed group it was improved to 10.78% at 18th month as shown in table 8.

Probing depth (PD)

Immediate group

The mean PD **mesially,** at baseline was found to be 3.14±0.35 mm that decreased to 2.57±0.74mm at the end of 9 month; 2.14±0.34mm at 18 months. **Distally** at baseline, it was 3.00±0.53 mm that decreased to 2.57±0.41mm at the end of 9 month; 2.00±0.96 mm at 18 months**. Buccally** at baseline, it was 2.71±1.42 mm that decreased to 2.28±0.45mm at the end of 9 month; 1.63±0.53mm at 18 months. **Lingually** at baseline, it was 2.50±0.49 mm that decreased to 2.14±0.35mm at the end of 9 month; 2.02±0.46 mm at 18 months as shown in table 7.

In percentage, **mesially, distally, buccally,** and **lingually** it was 19.33%, 22.93%, 6.2%, 5.9% reduction respectively as shown in table 9.

Delayed group

The mean PD **mesially,** at baseline was found to be 3.00±1.19 mm that decreased to 2.42±0.50 mm at the end of 9 month and 2.00± 1.35mm at 18 months. **Distally** at baseline, it was 3.14±0.55 mm that decreased to 2.42±0.45mm at the end of 9 month; 2.14±0.84mm at 18 months**. Buccally** at baseline, it was 2.57±0.49 mm that decreased to 2.42±0.44 mm at the end of 9 month; 1.85±0.22mm at 18 months. **Lingually** at baseline, it was 2.35±0.44 mm that decreased to 2.21±0.46 mm at the end of 9 month; 1.92±0.18mm at 18 months as shown in table 7.

In percentage, **mesially, distally, buccally,** and **lingually** it was 33.33, 31.85, 28.02%, 18.29% reduction respectively as shown in table 9.

Peri-implant bone loss

In immediate, the mean peri-implant bone loss at baseline was found to be 1.04±0.43 mm that increased to 1.12±0.34 mm at the end of 9 month and 1.10±0.39mm at 18 months. In delayed group at baseline, it was 1.08±0.25mm that increased to 1.18 ± 0.84mm at the end of 9 month and 1.29±0.24mm at 18 months. On comparison between delayed & immediate group, it was not statistically significant ($p>0.05$) as shown in table 6.

In percentage the immediate group there was 13.46% reduction and in delayed group it was 15.62% at 18^{th} month as shown in table 8.

Table 1; Immediate & delayed group difference in mean plaque index at baseline, 9 and 18 months (score)

Parameters	Immediate	Delayed	P Value
	Mean ± SD	Mean ± SD	
Baseline	0.24 ± 0.48	0.14 ± 0.37	>0.05*
9th month	0.42 ± 0.55	0.57 ± 0.53	>0.05*
18th month	0.57 ± 0.53	0.71 ± 0.48	> 0.05*

Table 2; Immediate & delayed group difference in mean soft tissue index at baseline, 9 and 18 months (score)

Parameters	Immediate	Delayed	P Value
	Mean ± SD	Mean ± SD	
Baseline	0.14±0.32	0.14± 0.43	>0.05*
9th month	0.28 ± 0.33	0.28 ± 0.48	>0.05*
18th month	0.28 ± 0.48	0.28 ± 0.48	> 0.05*

Table 3; Immediate & delayed group difference in mean width of keratinized mucosa at baseline 9 and 18 months (mm)

Parameters	Immediate	Delayed	P Value
	Mean ± SD	Mean ± SD	
Baseline	5.00 ± 1.08	5.00 ± 1.29	>0.05*
9th month	4.80 ± 0.69	4.64 ± 1.65	>0.05*
18th month	4.71 ± 0.75	4.57± 1.62	> 0.05*

Table 4; **Immediate & delayed group difference in mean thickness of peri-implant mucosa at baseline, 9 and 18 months. (mm)**

Parameters	Immediate	Delayed	P Value
	Mean ± SD	Mean ± SD	
Baseline	2.07 ± 0.41	1.92 ± 0.55	>0.05*
9th month	2.42 ± 0.81	2.35 ± 0.37	>0.05*
18th month	2.50 ± 0.86	2.42 ± 0.50	> 0.05*

Table 5; **Immediate & delayed group difference in mean papilla index at baseline, 9 and 18 months. (mm)**

Parameters	Immediate	Delayed	P Value
	Mean ± SD	Mean ± SD	
Baseline	2.57 ± 0.97	2.64 ± 0.74	>0.05*
9th month	2.71 ± 0.73	2.71 ± 0.75	>0.05*
18th month	2.85 ± 0.83	2.92 ± 0.18	> 0.05*

Table 6; Immediate& delayed group difference in mean peri-implant bone loss at baseline, 9 and 18 months. (mm)

Parameters	Immediate	Delayed	P Value
	Mean ± SD	Mean ± SD	
Baseline	1.043 ± 0.48	1.08 ± 0.25	>0.05*
9th month	1.12 ± 0.34	1.18 ± 0.84	>0.05*
18th month	1.10 ± 0.39	1.28 ± 0.24	> 0.05*

Table 7; Immediate & delayed group difference in mean probing depth at baseline, 9 and 18 months (mm)

Parameters	Immediate	Delayed	P value
Mesially			
Baseline	3.14 ± 0.35	3.00 ± 1.19	>0.05*
9th month	2.57 ± 0.74	2.42 ± 0.50	>0.05*
18th month	2.14 ± 0.34	2.00 ± 1.35	>0.05*
Distally			
Baseline	3.00 ± 0.53	3.14 ± 0.55	>0.05*
9th month	2.57 ± 0.41	2.42 ± 0.45	>0.05*
18th month	2.00 ± 0.96	2.14± 0.84	>0.05*
Buccally			
Baseline	2.71 ± 1.42	2.57 ± 0.49	>0.05*
9th month	2.28 ± 0.45	2.42 ± 0.44	>0.05*
18th month	1.63 ± 0.53	1.85 ± 0.22	>0.05*
Lingually			
Baseline	2.50± 0.49	2.35± 0.44	>0.05*
9th month	2.14 ± 0.35	2.21 ± 0.46	>0.05*
18th month	2.02 ± 0.46	1.92 ± 0.18	>0.05*

* p –value between baseline, 9 and 18 months is >0.05 denotes not statistically difference at 5 % level.

Table 8; Immediate and delayed group difference in (%) percentage of width, thickness of mucosa, papilla index and peri-implant bone loss at baseline, 9 and 18 months

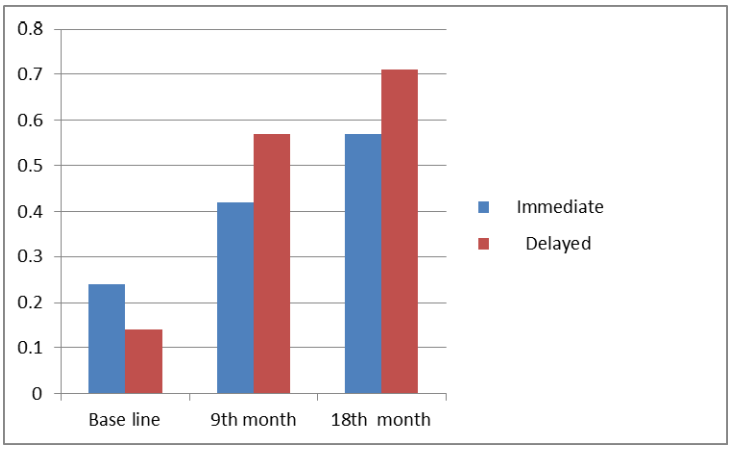
Parameters	Immediate (%)		Delayed (%)	
	9months	18 months	9 months	18 months
Width of keratinized gingiva (loss)	4	5.8	5.36	8.6
Thickness of peri-implant mucosa(gain)	6.9	24.15	22.39	25.9
Papilla index (gain)	5.4	10.89	2.6	10.78
Peri-implant bone loss (loss)	7.69	13.46	9.25	15.62

Table 9; Immediate and delayed group difference in (%) percentage of probing depth at baseline, 9 and 18 months

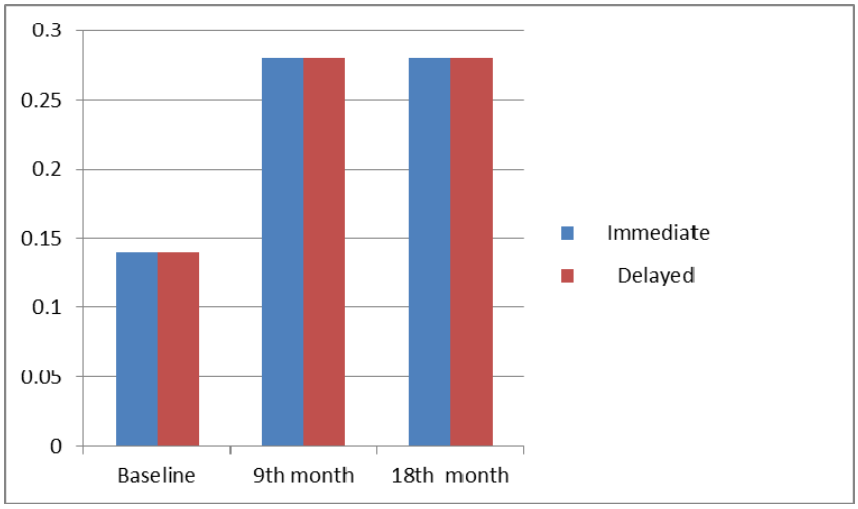
Pocket depth (reduction)	Immediate (%)		Delayed (%)	
	9months	18 months	9 months	18 months
Mesially	18.15	31.85	19.33	33.33
Distally	14.33	33.33	22.93	31.85
Bucally	15.55	39.85	6.2	28.02
Lingually	14.44	25.00	5.9	18.29

GRAPHS

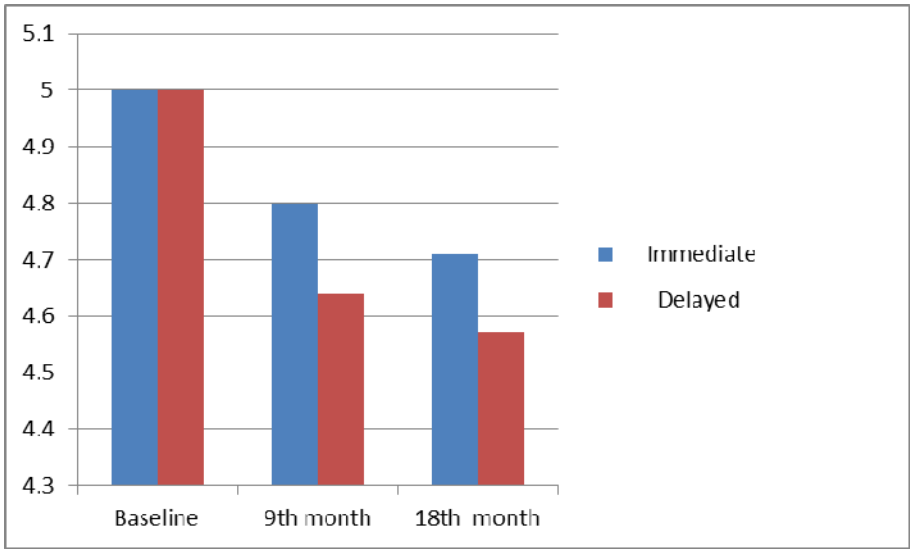
Graph 1; Comparison of mean plaque index between immediate & delayed groups at baseline, 9 and 18 months



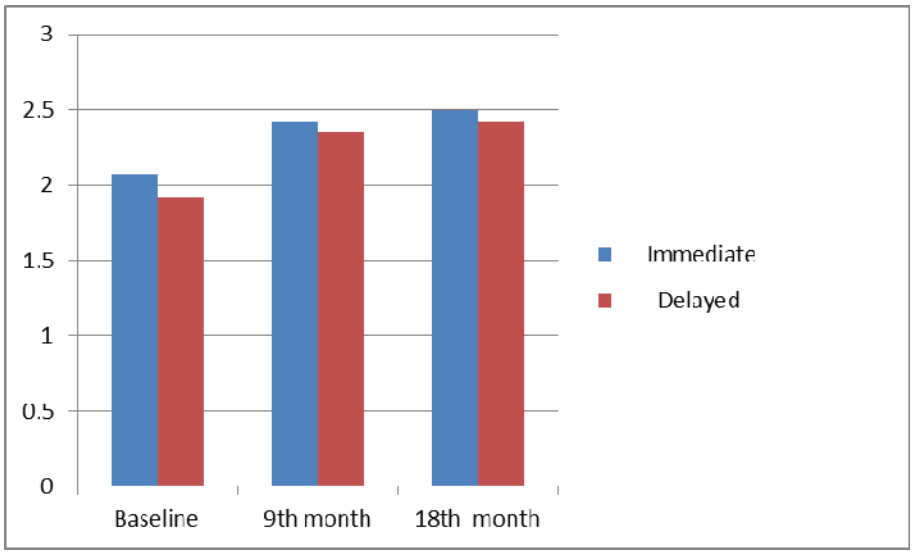
Graph 2; Comparison of mean soft tissue index between immediate and delayed groups at baseline, 9 and 18 months



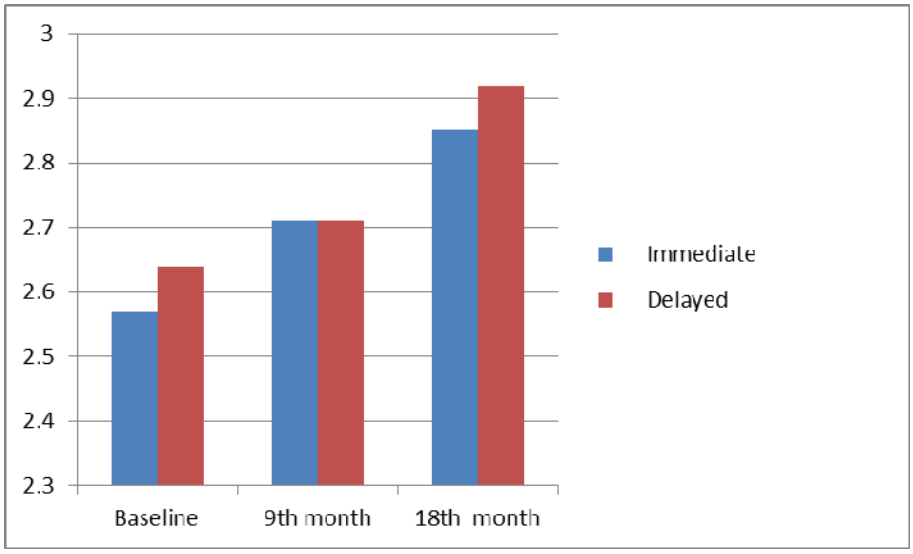
Graph 3; Comparison of mean width of keratinized mucosa between immediate and delayed groups at baseline, 9 and 18 months



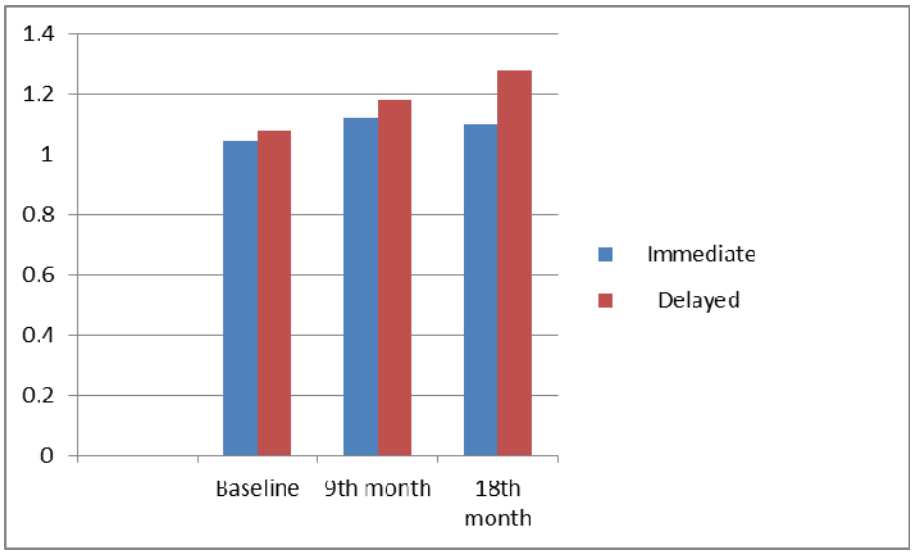
Graph 4; Comparison of mean thickness of mucosa between immediate and delayed groups at baseline, 9 and 18 months.



Graph 5; Comparison of mean papilla index between immediate and delayed groups at baseline, 9 and 18 months

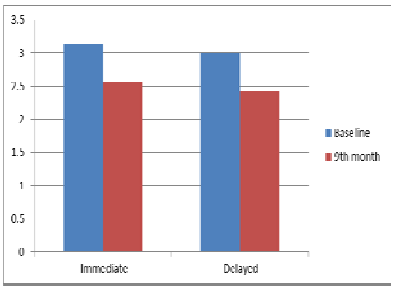


Graph 6; Comparison of mean peri-implant bone loss between immediate and delayed groups at baseline, 9 and 18 months

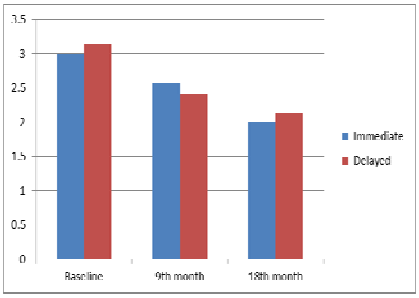


Graph 7; Comparison of mean probing depth between immediate & delayed groups at baseline, 9 and 18 months

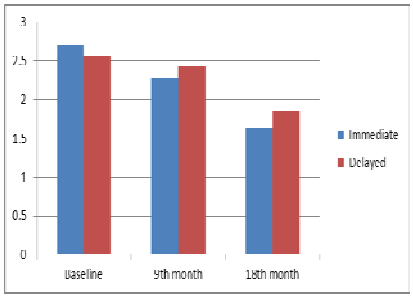
Mesially



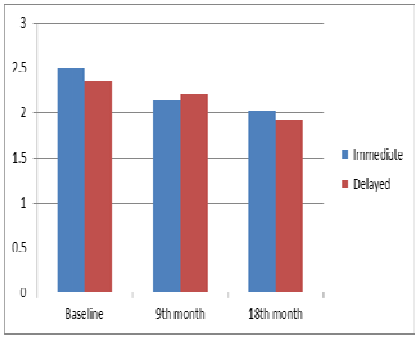
Distally



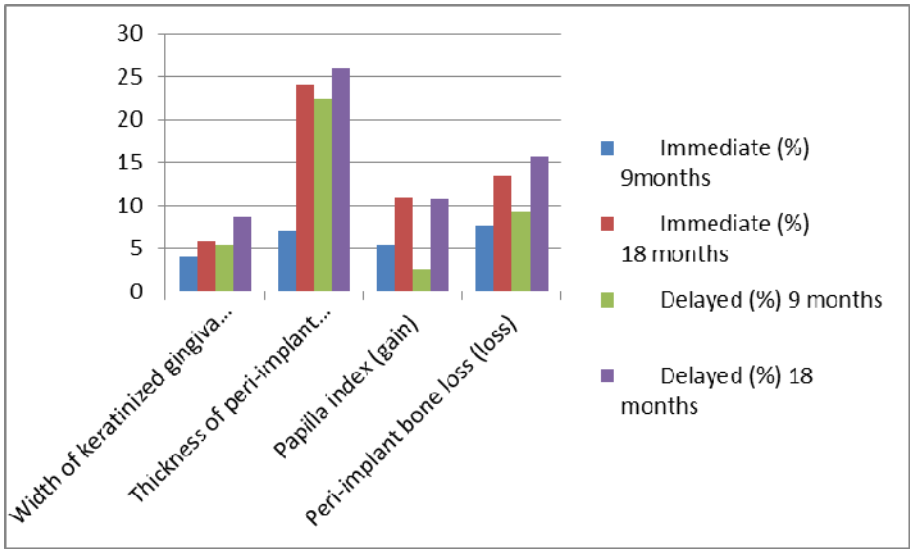
Buccally



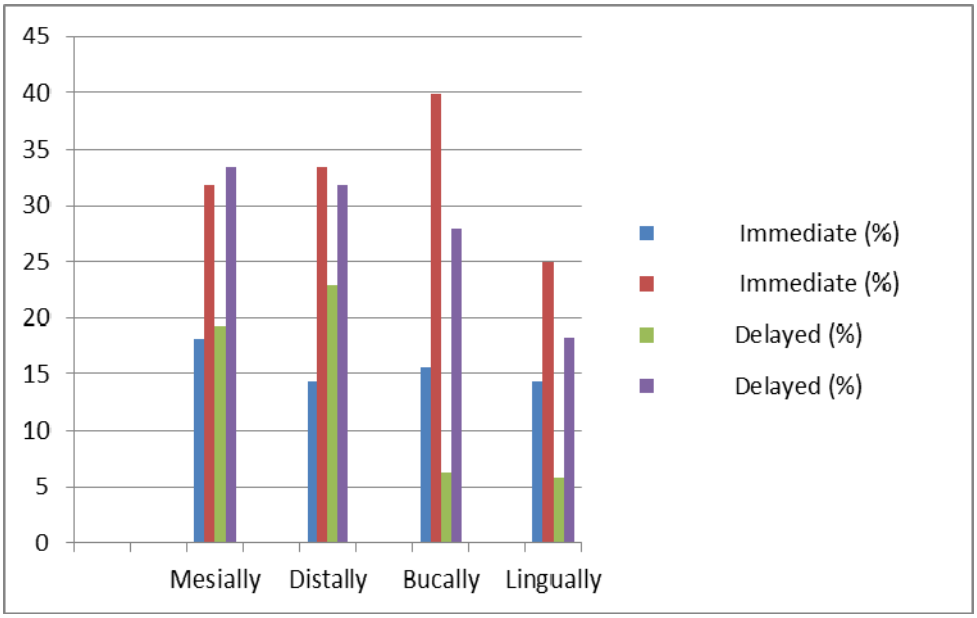
Lingually



Graph 8 ; Comparison between groups in (%) percentage level of width, thickness of mucosa, papilla index and peri-implant bone loss



Graph 9; Comparison between groups in (%) percentage level of mesial, distal, buccal, lingual probing depth at baseline, 18 months.



The goal of modern dentistry is to return the patients to oral health in a predictable fashion. The single tooth implant survival rates have progressively improved.[77, 78] The outcome of these implants depends on aesthetics, soft and hard tissue changes, patient satisfaction and complications.[17] With advancement in implant dentistry, more progressive treatment strategies have developed either in placement or loading of the implants.[78]

Clinician and patient dependent factors may play an important role in the aesthetic outcome of the single tooth implants.[32] Clinician dependent factors which includes proper three dimensional implant positions and angulation, as well as appropriate contour of the provisional restoration. Patient dependent factors which includes the bone level, hard and soft tissue relationship, bone thickness, and soft tissue biotype.

Present study was conducted to evaluate the two methods of implant placement. The first method was immediate implant protocol by placing the implant in the fresh extraction socket. The second method was traditional delayed implant protocol by placing the implant in healed extraction socket.

In this study, there was no statistically significant ($p>0.05$) mean plaque score difference, found between groups at baseline, 9 and 18 months. This proves that the patients maintained the good oral hygiene at 6 month study period and gradually decreased at follow-up time. This is in accordance with **Weber HP et al. (2000)[5]** and **Renvert S et al. (2009)[79]** study showed the same results and explained the lack of oral hygiene maintenance. Despite the fact that proper plaque control, elimination of peri-

implant mucosal inflammation, control of gingival and periodontal disease of adjacent teeth are considered to be essential for the long term maintenance of implants.[80]

In this study, there was no statistically significant ($p>0.05$) difference in the width of keratinized mucosa between groups at baseline, 9 and 18 months. But there was a significant percentage difference found between two groups, in which immediate group had more significant difference of 5.8% reduction. These results concur with the studies done by **Bouri et al. (2008)[19]**, who observed that wider zone of keratinized mucosa (>2mm) had less plaque accumulation and mucosal inflammation. This wider zone had more resistant to forces of mastication and frictional contact that occurs during oral hygiene procedure.[81] This is agreed with present results because no severe recession and inflammation was noted between groups.

In this study, there was no statistically significant ($p>0.05$) difference in mean thickness of per-implant mucosa were found between groups at baseline, 9 and 18 months. Immediate and delayed groups had greater than 1mm of mucosa thickness which was classified under thick biotype. In this current study, no statistical difference was found in thickness of mucosa between groups. But on clinical examination, significant mucosal thickness was noticed after the crown placement. **Henrikkson et al. (2004)[55]** found the same results and also proved significant increase in the buccal volume of peri-implant tissue after crown placement. **Kan JYK et al. (2004)[42]** described the gingival biotype as being thick or thin. A thick biotype implies more fibrotic tissue, more vascularization that was more resistance to recession. Thin gingival tissue has less underlying bone support and blood supply and

also more chances of recession. This agreed with our results that all gingival biotype in the study has greater than 1mm thickness with no recession.

In this study, there was no statistically significant difference ($p>0.05$) in mean papilla index between groups at baseline, 9 and 18 month. This is in accordance with the study done by **Schropp et al. (2005)**[72] who observed that presence of the interproximal papilla is not influenced by early or delayed-immediate with occlusal loading following 18 months period. But in this study, the improved papilla fill was observed from the time of crown placement to 1 year period that was 10.80% in immediate and 10.78% in delayed implants. This finding is agreedin with previous reports found in the literature **(Jemt 1997, 1999; Chang et al. 1999; Choquet et al. 2001)**[48,50,18]**.**

In this study, there was no statistically significant ($p>0.05$) difference in mean probing depth between groups at baseline, 9 and 18 months. Probing depth was seen to be decreased from the time of crown placement to 12 months in both groups. Percentage of probing depth reduction was smaller extent 27.87% for delayed group, compared with immediate group 32.50%. In both groups, a mean probing depth was approximately 2.38 mm, found at 12 months follow-up, which may be considered to be acceptable with **Schropp et al. (2005)**[15] study which is 4 mm. However, it is reasonable to assume that probing depth not exceeding 4.0 mm are preferable to facilitate the patient's ability for self-performed plaque control as well as accessibility for proper professional peri-implant cleaning.

Analysis of the crestal bone levels assessed on RVG (Radio Visio Graph) showed that bone loss occurred at the proximal surfaces of implants within the

observation period of present study in both the groups. The average mean bone loss was 1.10 mm in the immediate group and 1.28 in the delayed group from the crown placement to 12 months period. These results concur with the study done by **Grunder et al. (1999)**[66] who evaluated immediate and delayed-immediate placement of the implants after 12 months of loading found that bone loss was about 0.8 mm inter proximally. The present results also meet the success criteria for implant treatment proposed, in the consensus report of the 1st European Workshop on Periodontology: "The criteria of success include average bone loss of less than 1.5 mm during the first year after insertion of the prostheses" **(Albrektsson & Isidor 1994).**[43]

Thus the success rate and aesthetic outcome of single tooth implants placed either anterior or posterior region in the present study had a favourable clinical and radiological outcome using the two different placement methods. There was no statistically significant ($p>0.05$) difference noted in between two groups.

However, limitations of this study included,

- Small sample size
- Implant placed irrespective of anterior or posterior region
- No contralateral sites were selected
- Lack of implant stability test

In order to evaluate the proper clinical parameter and biological osseointegration, a study design of larger sample size with proper selection of the patient should be needed.

The study was designed and conducted in the Department of Periodontics, JKK Nattraja Dental College and Hospital, komarapalayam, Tamilnadu.

This 18 months study was done to evaluate the clinical and radiological parameters of 7 immediate and 7 delayed single tooth implants in respect to the method of placement. All the patients were followed up for 9 and 18 months corresponding to a functional loading time of 4 months and 12 months respectively. All the implants were remained in function during one year after the crown restoration.

The Plaque index, soft tissue index, probing depth, width of keratinized mucosa, thickness of peri-implant mucosa, papilla index and peri-implant bone loss were recorded at baseline, 9^{th} and 18 months intervals. The peri-implant bone loss was assessed by using RVG by sopro imaging software. The data were subjected to statistical analysis. From the results obtained, the following conclusions were arrived:

1. Single tooth implant revealed higher success rates in both groups with positive tissue response.
2. The minimum 1mm thickness of peri-implant mucosa is needed for maintaining the implants without recession.
3. Peri-implant inflammation was less for implants surrounded by more than 2mm of keratinized mucosa in both groups.
4. Improved papilla fill was observed in both groups.
5. Average peri-implant bone loss in both groups was less than 1.5 mm after the 12 year period of function.

The results obtained here clearly demonstrated that self-threaded internal hex, titanium implants placed according to a delayed or immediate technique can be used successfully over a period of 12 months. High successful rates were achieved without severe peri-implant complications.

However, it is necessary to have a large sample size with proper selection of the patients are needed to evaluate the clinical and radiological parameters. Also further studies need to be carried out to evaluate the relationship between peri-implant soft and hard tissue in respect to the placement of implants.

1. Carl E. Mish, Contemporary implant dentistry – *third edition.*

2. Limor Avivi-Arber, George A. Zarb. Clinical effectiveness of implant-supported single tooth replacement: The Toronto stydy. *Int J Oral Maxillofac Implants 1996;11:311-321*

3. Jan Lindhe, Clinical periodontology and implant dentistry. *Fifth edition.*

4. Ronald E. Jung, Bjarni E. Pietrursson, Roland Glauser, Anja Zembic. A systemic review of the 5- year survival and complication rates of implant-supported single crowns. *Clin Oral Impl Res. 19, 2008; 119-130.*

5. Weber HP, Crohin CC, Fiorellini JP. A five – year prospective clinical and radiographic study of non-submerged dental implants. *Clin Oral Impl Res. 19, 2000:11:144-153.*

6. Anders Ekfeltdt, LDS, Odont Dr/Gunnar E, Carlsson. Clinical evaluation of single tooth restorations supported by osseointegated implants: A retrospective study. *Int J Oral Maxillofac Implants 1994; 9: 179-183*

7. Myron, Nevins. Implant therapy. *Second edition. Quintessence publishing.*

8. Rosenquist B, Grenthe B. Immediate placement of implant into extraction sockets: Implant survival rates. *Int J Oral Maxillofac Implants 1996;11:205-209*

9. Izchak Barzilay, Gerald N, Graser, Bejan Iranpour. Immediate implantation of a pure titanium into an extraction socket: Report of a pilot procedure. *Int J Oral Maxillofac Implants 1991;6: 277-284*

10. Den Hartog L, Huddleston slater JJR, Vissink, Meijer HJA. Treatment outcome of immediate, early and conventional single tooth implants in the aesthetic zone: a systemic review to survival, bone level, soft tissue, aesthetics and patient satisfaction. *Journal of Clinical Periodontology 2008; 35: 1073-1086.*

11. Becker BE, Becker W, Ricci. A and Geurs. A prospective clinical trial of endosseous screw –shaped implants placed at the time of tooth extraction without augmentation*. Journal of Periodontology ,1998 Aug (920-926).*

12. Devorah Schwartz-Arad and Gavriel Chaushu. Placement of implants into fresh extraction sites: 4 to 7 years retrospective evaluation of 95 implants. *Journal of Periodontology 1997 Nov (1110-1116).*

13. Ueli Grunder. Stability of the mucosal topography around single tooth implants and adjacent teeth: 1- year results. *Int J Periodontics Restorative Dent 2000;20:11-17*

14. Marco Esposito, Maria Gabriella Grusovin, Yun Sgane Chew. One-stage versus two-stage implant placement. A systemic review of randomised controlled clinical trials. *Eur J Oral implantol 2009; 2(2): 91-99.*

15. Schropp L, Kostopoulos L, Wenzel A, Isidor F. Clinical and radiographic performance of delayed-immediate single tooth implant placement associated with peri-implant bone defects. A 2 year prospective, controlled, randomized follow-up report. *Journal of Clinical Periodontology; 2005; 32: 480-487.*

16. Juan C. Ibanez, Marcelo J, Jahhan, Juan A. Zamar. Performance of double acid etched surface external hex titanium implants in relation to one and two stage surgical procedure. *Journal of Periodontal 2003;74:1575-1581).*

17. Eugenio Rome, Diego Lops, Alessandro Rossi, Stefano Sterelli, Rozza. Surgical and prosthetic management of interproximal region with single-implant restorations: 1- year prospective study. *Journal of Periodontology 2008; 79:1048-1055.*

18. Vincent Choquet, Marc Hermans, Philippe Adriaanessens, Phillippe Daelemans, Dennis. Clinical and radiological evaluation of the papilla level adjacent to single tooth dental implants. A retrospective study in the maxillary anterior region. *Journal of Periodontology2001; 72: 1364-1371.*

19. Anil Bouri Jr, Nabil Bissada, Mohammad S. Al-Zahrani, Fady Faddoul, Imad Nouneh. Width of keratinized gingiva and the Health status of the supporting Tissue around dental implants. *Int J Oral Maxillofac Implants 2008;23 (supple); 116—127.*

20. Giovanni E. Salvi, Med Dent, Nilklaus P. Lang. Diagnostic parameters for monitoring peri-implant conditions. *Int J Oral Maxillofac Implants 2004; 19(supple); 323-326.*

21. Tomas Linkeviccius, Peteris Apse, Dr Habil, Simonas grybauskas, Algirdas Puisys.The influence of soft tissue thickness on crestal bone changes around implant: A 1-year prospective controlled clinical trial. *Int J Oral Maxillofac Implants 2009; 24:712-719.*

22. Joseph J. K. Kan, Kitichai Rungcharassaeng, Kiyotaka Umezu and John C. Kois. Dimensions of peri-implant mucosa: An evaluation of maxillary anterior single implants in humans. *Journal of Periodonology 2003; 74:557-562*

23. Urs Bragger, Walter Burgin, Niklaus.P. Lang, Danial Buser. Digital substraction radiography for the assessment of changes in peri-implant bone density. *Int J Oral Maxillofac Implants 1991;6:160-166.*

24. William Becker, Samuel E. Lynch, Ulf Lekholm, Burton E. Becker. A comparision of ePIFE membrane alone or in combination with IGF-I or DFDB bone formation in around immediate implants. *Journal of Periodontology.1992 Nov.*

25. Marlin E. Gher, George quintero, Danial Assad, Edward Monaco. Bone grafting and GTR for immediate dental implants in humans. *Journal of Periodontology.1994 Sep (881-891).*

26. Lars Schropp, Ann wenzel,Odont, and Lambros Kostopoulos. Impact of conventional tomography on prediction of the appropriate implant size. *Oral Surg Ral pathol, Oral Radiol Endod 2001; 92: 458-63.*

27. Els De Smet, Danial Van Steen Berghe, Marc Quirynen, Iqnace Naert. The influence of plaque or excessive loading on marginal soft and hard tissue reaction around implants; A review of literature and experience. *Int J Periodontics Restorative Dent 2001;21:381-393*

28. Soren Schou, Palle Holmstrup, Kaj Stoltze, Erik Hjorting Hansen. Probing around implants and teeth with healthy or inflamed peri-implant mucosa. A histological comparision in cynomolgus monkeys. *Clin. Oral Impl Res;13,2002:113-126*

29. Joseph Y.K. Kan, Kitichai Rungcharassaeng, Jaime Lozada. Immediate placement and provisionalization of maxillary anterior single implants: 1- year prospective study. *Int J Oral Maxillofac Implants 2003; 18:31-39.*

30. Lars Schropp, Ann wenzel,Odont, and Lambros Kostopoulos. Bone healing and soft tissue contour changes following single tooth extraction: A clinical and radiographic 12-month prospective study. *Int J Periodontics Restorative Dent 2003; 23:313-323.*

31. Marco Esposito, Maria Gabriella Grusovin, Mark Willing. The effectiveness of immediate, early and conventional loading of dental implants: A Cochrane systematic review of randomized controlled clinical trials. *Int J Oral Maxillofac Implants 2007; 22:893-904.*

32. Marco Degidi, Arthur Belem Novaes, Diego Nardi. Outcome analysis of immediately placed, immediately restored implants in the aesthetic area: The clinical relevance of different inter-implant distance. *Journal of periodontology 2008; 79:1056-1061.*

33. Eugenio Romeo, Diego Lops, Alessandro Rossi, Stefano storelli. Surgical and prosthetic management of interproximal region with single implant restorations: 1 year prospective study. *Journal of Periodontology 2008; 79:1048-1055.*

34. Luigi Guida, Giovannna lezzi, Marco Annunziata, Antonio Salierno. Immediate placement and loading of dental dental implants: A human histological case report. *Journal of Periodontal 2008;79:575-581.*

35. Danial Buser, Stephen T, Chen, Hans Peter weler. Early implant placement following single tooth extraction in the esthetic zone: biological rationale and surgical procedures. *Int J Periodontics Restorative Dent 2008; 28:441-451.*

36. Robertto crepsi, Palo Cappare, Enrico Gherlone, George E, Romanos. Immediate versus delayed loading of dental implants placed in fresh

extraction sockets in maxillary esthetic zones. A clinical comparative study. *Int J Oral Maxillofac Implants 2008;23:753-758.*

37. William Becker & Moshe Goldstein. Immediate implant placement; Treatment planning and surgical steps for successful outcome. *Journal of Periodontology 2000;Vol.47:2008;79-89.*

38. Karl. Erik kahnberg. Immediate implant placement in fresh extraction sockets. A Clinical report. *Int J Oral Maxillofac Implants 2009;24:282-288.*

39. Linda Grutter, Urs Belser. Implant loading protocols for the partially edentulous esthetic zone. *Int J Oral Maxillofac Implants 2009; 24(supple) 169-179.*

40. Pedro Tortamano; Luiz otovio Alves Camargo, Marina stella Bello-Silva. Immediate placement and restoration in the esthetic zone; A prospective study of 18 months follow-up. *Int J Oral Maxillofac Implants 2010; 25:345-350.*

41. Paseol Valentini, David A bensur, Jacques F. Albertini, Marcel Rocchessani. Immediate provisionalization of single extraction site implants in the esthetic zone: A clinical evaluation. **.** *Int J Periodontics Restorative Dent 2010; 30:41-51.*

42. Joseph Y. K. Kan, Taichiro Morimoto, Kitichai Rungcharassaeng. Gingival biotype assessment in the esthetic zone: Visual versus direct measurement. *Int J Periodontics Restorative Dent 2010; 30:237-243.*

43. Tomas albrektsson, Evert Dahl, Lars Enbom, Sigfrid Engevall, Bo Engquist. A Swedish multicentre study of 8139 consecutively inserted nobelpharma implants. *J periodontal 1988 May (287-296).*

44. Torsent Jemt, William R. Laney, David Harris, Patricck. Osseointegrated implants for single tooth replacement: A 1-year report from a multicentre prospective study. *Int J Oral Maxillofac Implants 1991; 6:29-36.*

45. William R. Laney, Torsent Jemt, David Harris, Patrick J. Henry. Osseointegrated implants for single tooth replacement: Progress report from a multicentre prospective study after 3 years. *Int J Oral Maxillofac Implants 1994; 9:49-54.*

46. Bert Andersson, Per Odman, Ann-Marie Lindvall, Berit Lithner. Single tooth restorations supported by osseointegrated implants: Results and experiences from a prospective study after 2 to 3 years. *Int J Oral Maxillofac Implants 1995; 10:702-711.*

47. Patric J. Henry, William R. Laney, Torsent Jemt, David Harris, Paul H. J. Krogh. Osseointegrated implants for single tooth replacement: A prospective 5 – year multicentre Study. *Int J Oral Maxillofac Implants 1996; 11:450-455).*

48. Torsent Jemt. Regeneration of gingival papilla after single-implant treatment. *Int J Periodontics Restorative Dent 1997; 17:327-333*

49. Hebert Scheller, Pi Urgell, Christina Kultje, Iven Klineberg, Perry V Goldberg. A 5- year multicentre study on implant-supported single crown restorations. *Int J Oral Maxillofac Implants 1998; 13:212-218.*

50. Chang M , Wennstrom Jl, Odman, P. Andersson B. Implant supported single tooth replacements compared to contralateral teeth. *Clin Oral Impl Res 1999;10:185-194.*

51. George E. Romanos,Georg H. Nentwig. Single tooth replacements with a progressive thread design implant system: A retrospective clinical report. *Int J Oral Maxillofac Implants 2000;15:831-836.*

52. D.P. Tarnow: S.C. Cho, S.S. Wallace. The effect of inter-implant distance on the height of inter-implant bone crest. *J Periodontal 2000; 71:546-549.*

53. Lyndon Cooper, Felton, Carl F. Kugelberg, Stephen Ellner,Nancy Chaffee. A multicentre 12 month evaluation of single tooth implants restored 3 weeks after 1 stage surgery. *Int J Oral Maxillofac Implants 2001;16:182-192.*

54. Jose Fabio Gastaldo, Patricia Romos Cury and Wilson Roberto Sendyk. Effect of the vertical and horizontal distances between adjacent implants and between a tooth and an implant on the incidence of interproximal papilla. *J Periodontal; 2004:75:1242-1246.*

55. Kristina Henriksson, Torsent Jemt. Measurement of soft tissue volume in association with single –implant restorations: A 1-year comparative

study after abutment connection surgery. *Clinical implant Dentistry and Related Research 2004; Vol;6:no4:183.*

56. Richard S. Appletion, Pirkka V. Nummikoski, Mark A. Pigno.A radiographic assessment of progressive loading on bone around single osseointegrated implants in the posterior maxilla. *Clin Oral Impl Res 16, 2005;161-167.*

57. Mark r Ryser, Michael S, Block and Donald E. Mercante. Correlation of papilla to crestal bone levels around single tooth implants in immediate or delayed crown protocols. *Int J Oral Maxillofac Implants 2005;63:1184-1195.*

58. Eugenio Romeo, Diego Lops, Leonardo Amorfini, Matteo Chiapasco. . Clinical and radiological evaluation of small-diameter (3.3mm) implants followed for 1-7 years: a longitudinal study. *Clin Oral Impl Res 17;2006:139-148.*

59. Leo Meijindert, Henny J. A. Meijer, Kees Stellinggsma, Gerry M. Raghoebar. Evaluation of esthetics of sigle tooth replacements using different bone augmentation procedures: a prospective randomized clinical study. *Clin Oral Impl Res 18;2007:715-719.*

60. Giuseppe Cardaropoli, Ulf Lekholm, Jan L. Wennstrom. Tissue alteration at implant supported single tooth replacenents: a 1-year prospective clinical study. *Clin Oral Impl Res 2006;17:165-171.*

61. Georg Watzak, Werner Zechner, Dieter Busenlechner, Christof Amhart. Radiological and clinical follow-up of machined and anodized surface implants after mean functional loading for 33 months. *Clin Oral Impl Res 2006;17:651-657.*

62. Carl E. Misch, Francine Misch-Dietsh, Jennifer Silc, Eliane Barboza. Posterior implant single-tooth replacement and status of adjacent teeth during a 10- year period. A retrospective study. *J Periodontal 2008;79;2378-2382.*

63. Peyman shahindi, Zhimon Jacobson, Serge Dibart, Jacob Pourati, Martha Nunn. Efficacy of a new technique in implant dentistry: A preliminary study. *J Oral Maxillofac Implants 2008;23:926-934.*

64. Young Kyun Kim, Su-Gwan Kim, Pil-young Yun. Prognosis of single molar implants: A retrospective study. *Int J Periodontics Restorative Dent 2010; 30:401-407.*

65. Raymond A. Yukna. Clinical comparision of hydroxyapatite –coated titanium dental implants placed in fresh extraction sockets and healed sites. *Journal of Periodontology 1991 Jul (468- 472).*

66. Ueli Grunder, Naoki Hatano, William J. Jackson, Steffen Kohler, Marvin Werbitt. A 3-year prospective multicentre follow-up report on the immediate and delayed-immediate placement of implants. *J Oral Maxillofac Implants 1999;14:210-216.*

67. Lars Schropp, Lambros Kostopoulos, Ann Wenzel. Bone healing following immediate versus delayed placement of titanium implants into extraction sockets. A prospective clinical study. *Int J Oral Maxillofac Implants 2003; 18:189-199.*

68. Ugo Covani, Claudia Bortolaia, Antonio Barone and Ludovico Sbordone. Bucco lingual crestal bone changes after immediate and delayed implant placement. *Journal of Periodontal 2004;75:1605-1612.*

69. Lars schropp, Flemming Isidor, L abros Kostopoulos, Ann Wenzel. Patient experience of, and satisfaction with, delayed-immediate versus delayed single tooth implant placement. *Clin Oral Impl Res 2004;15:498-503*

70. Devorah Schwartz-Arad, Yael Yaniv, Liran Levin, and Israel Kaffe. A radiological evaluation of cervical bone loss associated with immediate and delayed implants placed for fixed restorations in edentulous jaws. *Journal of periodontology 2004;75:652-657*

71. Zetu L, Wang HL. Management of inter-dental or inter implant papilla. *Journal of clinical periodontology 2005;32:831-839*

72. Lars schropp, Flemming Isidor, Lambros Kostopoulos, Ann Wenzel. Inter proximal papilla levels early versus delayed placement of single – tooth implants. A controlled clinical trial. *Int J Oral Maxillofac Implants 2005;20:753-761*

73. Robert. A. Jaffin, Mathew Kolesar, Akshay Kumar, Satoshi Ishikawa,Joseph Fiorellini. The radiographic bone loss pattern adjacent to immediately placed, immediately loaded implants. *Int J Oral Maxillofac Implants 2007;22:187-194*

74. Marco Degidi, Diego Nardi and Adriano Piattelli. Peri-implant tissue and radiological bone levels in the immediately restored single tooth implant: A retrospective analysis. *Journal of Periodontal 2008;79:252-259.*

75. Momen A Atieh, Alan .G.T. Payne, Warwick.J. Duncan. Immediate placement or immediate restoration of single tooth implants for molar tooth replacement. A systemic review and meta-analysis. *Int J Oral Maxillofac Implants 2010; 25:401-415.*

76. Daniel Buser, William Martin, Belser. Optimizing esthetic for implant restoration in the anterior maxilla: Anatomic and surgical considerations. *Int J Oral Maxillofac Implants 2004;19 (suppl):43-61*

77. Ira H.Orenstein, Vincent Petrazzuolo, Harold f. Morris, and Shideru Ochi. Variables affecting survival of single tooth hydroxyapatite coated implants in anterior maxilla at 3 years. *Ann Periodontal 2000; 68-78.*

78. Rayan C. Taylor, Ddwin A. McGlumphy, Dimitris N. Tatakis, F. Michael Beck. Radiographic and clinical evaluation of single tooth

biolok implants: A 5 year study. *Int J Oral Maxillofac Implants 2004;19;849-854.*

79. Renvert S , Samuelsson E, Lidhal C, Persson GR. Mechanical non-surgical treatment of peri-implantitis: a double blind randomized clinical study. *Journal of Clinical Periodontology.2009;36:604-609*

80. Soft tissue enhancement around implants. *Periodontology 2000;Vol .47:2008:113-132.*

81. Abrahammsson I, Berglundh T, Wennstrom J, Lindhe J. Implant hard and soft tissues at different implant systems. A comparative study in dog. *Clin Oral Implants Res 1996;7:212-219*

ARMAMENTARIUM

Physio dispensor & implant kit

Surgical instruments

PRE OPERATIVE EVALUATION

Immediate – Case: 1 (tooth no 21)

Preoerative view

IOPA – Fractured 21

Diagnostic cast

Surgical stent

OPERATIVE VIEW

Extracted Socket in 21 & Extracted 21

Implant placed in 21 socket

Graft placed in 21

Suture placed

1 week post-operative view

PRE OPERATIVE EVALUATION

DELAYED – CASE: 2 (tooth no 22)

Preoperative view

Diagnostic stent with metal ball

IOPA with metal ball

Ridge mapping- in patient

Bone mapping – in cast

Surgical stent

OPERATIVE VIEW

Flap elevated & paralleling tool placed

Implant placed in 22

Suture placed

2 week Post opreative view

Healing abutment & final abutment placement with cementation of crown (2nd stage surgical procedures- after 3 months)

Healing abutment placement

3-4 Weeks of healing

Final abutment placement

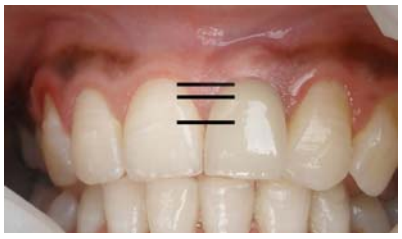
Cementation of prostheses

Clinical parameters

Case: 1 (Immediate – baseline)

Width of keratinized mucosa (mm)

Thickness of mucosa (mm)



Papilla index (score)

Probing depth

Case: 2 (Delayed- baseline)

Width of keratinized mucosa(mm)

Thickness of mucosa (mm)

Papilla Index (score)

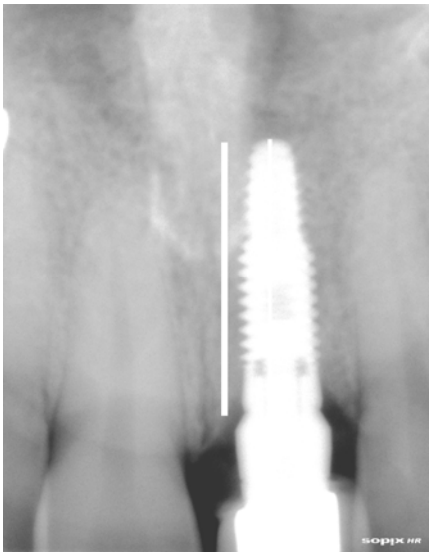
Probing depth

Radiological parameters

Case: 1(Immediate) IOPA- at placement

Case: 2 (Delayed) IOPA- at placement

RVG at baseline (bone loss)



RVG at baseline (bone loss)